Series 1935, No. 9 Issued April 1939

Soil Survey

Frontier County Nebraska

By
S. R. BACON
Bureau of Chemistry and Soils, in Charge
and
E. H. TYNER, W. L. BRUCE, DAVID FRANZEN, and D. B. DODSON
Nebraska Soil Survey

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
In cooperation with the
University of Nebraska, Conservation and Survey Division

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SOIL SURVEY OF FRONTIER COUNTY, NEBRASKA

By S. R. BACON, Bureau of Chemistry and Soils, United States Department of Agriculture, In Charge, and E. H. TYNER, W. L. BRUCE, DAVID FRANZEN, and D. B. DOBSON, State Soil Survey Department of the Conservation and Survey Division, University of Nebraska

United States Department of Agriculture, Bureau of Chemistry and Soils, in cooperation with the University of Nebraska, Conservation and Survey Division

COUNTY SURVEYED

Frontier County is in south-central Nebraska (fig. 1). Stockville, the county seat, situated near the center of the county, is about 200 miles southwest of Lincoln. The county, which is almost rectangular, is about 42 miles from east to west and 24 miles from north to south. The total area is 975 square miles, or 624,000 acres.

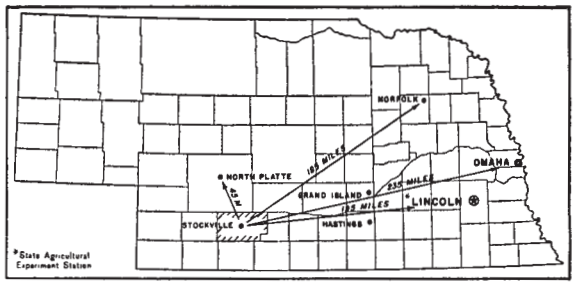

FIGURE 1.—Sketch map showing location of Frontier County, Nebr.

Physiographically, this county is part of a smooth gently eastward sloping loess-mantled plain. Erosion by Medicine, Red Willow, Deer, East Muddy, West Muddy, and Plum Creeks, and their numerous tributaries, has greatly modified the old plainlike surface. Over most of the county it has produced an intricate system of deep steep-sided drainageways separated by narrow flat-topped remnants of the old constructional plain. Few of the remnants exceed a mile in width. They are dotted here and there by small shallow basins, locally called lagoons. The central divides between the major drainageways are fairly continuous and have numerous spurs, some of which extend out many miles.

About 2 square miles of sand hills in Laird and Weaver Precincts fringe the western edge of the county. These are outliers of the sand-hill section of north-central Nebraska. They have an undulating to rolling relief, largely the result of wind action. The boundary between the sand hills and "hard lands" to the east is sharply defined.

The major streams and their principal tributaries are entrenched from 100 to 200 feet below the general level of the upland, and the sides of their valleys are short and steep, except in the vicinity of high terraces where the slopes, in places, are gradual. The valleys of the smaller tributaries are cut to a depth ranging from 20 to 75 feet below the upland. They are narrow and V-shaped at the heads of

the streams but become increasingly deeper, wider, and more gently sloping downstream. Soil slipping is common on the steeper slopes, resulting in terracelike shelves, known as catsteps.

Alluvial lands, including the terraces and flood plains along the major streams and their larger tributaries, occupy about 6.7 percent of the county. The largest developments border Medicine Creek where they are 1 mile wide in places.

The terraces are much more extensive than the flood plains. They are from 10 to 50 feet above the normal level of the streams and are not subject to overflow from the main channels. They are nearly level, except where dissected by shallow steep-sided drainageways issuing from the uplands. Abrupt slopes mark the transition from terrace levels to the flood plains in most places.

The flood plains, or first bottoms, occupy the lowest positions, lying from 2 to 10 feet above the normal flow of the streams. They are continuous along most of the larger watercourses and range from about 200 feet to slightly more than one-half mile in width. The bottoms have little relief, but they are modified in places by old and active stream channels, slight elevations, and shallow depressions. They are subject to overflow during periods of high water, but the slope down the valley and toward the channels is sufficient to remove the surplus water soon after the streams subside. Red Willow Creek overflows its flood plain rather frequently.

The average elevation of the county is about 2,600 feet above sea level, and the total range in elevation is about 700 feet. The highest point is in the northwestern part and the lowest in the southeastern part. The altitude at Eustis is 2,624 feet, at Stockville 2,482 feet, at Curtis 2,553 feet, and at Moorefield 2,826 feet.[1] With the exception of Moorefield, these towns are on stream terraces.

Nearly all of the county is well drained, and over a large part surface run-off is rapid and erosion severe. Poorly drained areas occur in only a few upland basins, in local marshy tracts on the flood plains, and around some artificial lakes and ponds.

With the exception of a small area in the northeastern corner, from which the run-off enters Platte River through Plum Creek, the drainage is effected through tributaries of Republican River, chief among which are Medicine, Red Willow, Deer, and Muddy Creeks. Red Willow and Medicine Creeks flow continuously, but the other creeks are intermittent or flow continuously only in their lower courses. All the streams have steep gradients and are actively deepening their channels. Water power is developed on Medicine Creek at Curtis and Maywood. Many of the streams are extending, through headward erosion, into the loessial uplands.

An abundance of good well water is readily obtained in all sections. Most of the upland wells range in depth from 150 to 300 feet, and the deepest ones are in the northern part of the county. Springs occur in places but are not important sources of water.

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[1] GANNETT, HENRY. A DICTIONARY OF ALTITUDES IN THE UNITED STATES. U. S. Geol. Survey Bull. 274, ed. 4, 1072 pp. 1906.

Native deciduous trees, chiefly willow, ash, elm, boxelder, hackberry, and cottonwood, grow in narrow strips along the larger drainageways. Scattered stands of red cedar and thickets of wild plum and chokecherry grow in some of the canyons. Few of the trees attain a merchantable size, but they have a local value for fuel and fence posts.

The first permanent settlement in the area now included in Frontier County was made along Medicine Creek in the early seventies. In 1872, the county was organized, and its original boundaries have remained unchanged. Settlers came mostly from Iowa, Illinois, Missouri, and other States to the east.

According to the Federal census, this county had 8,114 inhabitants in 1930, all classed as rural. The density of the population is given as 8.3 persons to the square mile. Settlement is densest in the valleys of Medicine and Plum Creeks and on the broader and smoother divides.

Curtis, the largest town, has a population of 960. A State agricultural school is located here. Eustis, with a population of 497, is a distributing center for farm implements, supplies, and produce. Volcanic ash for abrasive purposes is obtained in the vicinity of this town. Maywood, Moorefield, and Stockville are important trading points in the northern part of the county. Most of the people in the extreme southern part do their trading at McCook, Indianola, Bartley, and Cambridge in adjoining counties.

Transportation facilities are fair. All the towns except Stockville are served by a branch of the Chicago, Burlington & Quincy Railroad. No part of the county is more than 18 miles distant from a railroad, as there is a main line of the same system in adjoining counties to the south. The public-road system is well developed. State and Federal highways, most of which are surfaced with gravel, cross the county from east to west and from north to south. The county roads are of earth construction, and the more important ones are kept in good repair. Most roads follow land lines, except in the rougher areas where they conform to the topography.

Rural mail routes serve most sections, telephones are in common use, and the public-school system is highly developed.

CLIMATE

The climate is continental, with rather wide seasonal extremes. The winters are moderately long and cold, and the summers are warm. Cool weather, accompanied by considerable rain, prevails in the spring. The fall season is usually long, with moderate temperatures and only occasional rainy periods. The rainfall and humidity are low, and the rate of evaporation is high. Variations in relief are insufficient to cause any pronounced differences in climatic conditions. The climate in general is favorable for livestock raising and grain farming.

Table 1, compiled from records of the Weather Bureau station at Curtis, gives the normal monthly, seasonal, and annual temperature and precipitation for that station which are fairly representative for the county as a whole.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Curtis, Frontier County, Nebr.*

[Elevation, 2,553 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1934)	Total amount for the wettest year (1915)	Snow, average depth
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	27.8	71	−33	0.70	0.78	0.30	5.0
January	26.2	75	−32	.44	(1)	.35	4.2
February	29.2	77	−36	.68	.89	.90	7.1
Winter	27.7	77	−36	1.82	1.67	1.55	16.3
March	39.0	85	−14	1.26	.22	1.50	6.6
April	50.7	95	5	2.41	.35	4.00	3.7
May	60.7	102	20	3.16	.94	6.90	.6
Spring	50.1	102	−14	6.83	1.51	12.40	10.9
June	69.8	108	33	3.71	2.10	7.60	0
July	75.6	106	40	3.54	.32	6.20	0
August	74.0	106	34	3.14	2.33	7.00	0
Summer	73.1	108	33	10.39	4.75	20.80	0
September	64.9	104	20	1.84	1.65	1.60	0
October	52.1	95	0	1.46	.34	1.60	1.5
November	38.7	84	−12	.73	1.01	.30	1.8
Fall	51.9	104	−12	4.03	3.00	3.50	3.3
Year	50.7	108	−36	23.07	10.93	38.25	30.5

[1] Trace.

The precipitation varies greatly from year to year. About two-thirds of it falls during the principal part of the growing season—May to September, inclusive. Much of the precipitation comes as torrential rains which cause considerable erosion and loss of moisture through surface run-off. Droughts frequently occur in the latter part of July and August.

The average date of the last killing frost at Curtis is May 6, and that of the first is September 29. This gives an average frost-free season of 146 days, which is ample for the maturing of all the crops commonly grown. Killing frosts have been recorded as late as May 26 and as early as September 7.

The prevailing winds in the winter are from the northwest and in the summer from a southerly direction. Strong winds are common, but tornadoes are rare.

AGRICULTURAL HISTORY AND STATISTICS

Prior to the coming of white men, bands of Indians roamed the area now included in Frontier County, and buffaloes and antelopes grazed on the range. The first white people to utilize the agricultural resources of the area were cattlemen who, during the early sixties, drove large herds of Texas cattle across what is now the southwestern part of the county, en route to the railroad at Ogallala, Nebr., the end of the Texas trail. Most of the herds were allowed to graze for sev-

eral days on the luxuriant grasses in the valley of Red Willow Creek, before proceeding northward over the drier uplands to the Platte River Valley.

The first permanent settlements were made along Medicine Creek in the early seventies. Later, settlement spread rapidly throughout the alluvial lands and gradually onto the uplands. By 1900, most of the desirable land had been taken under the Homestead, Timber Claim, and Preemption Acts. In that year, 554,703 acres were included in farms, slightly more than one-half of which was improved.

At present practically all of the prairie sod in areas topographically suited to cultivation has been broken for the production of crops. According to the 1935 census, 608,134 acres, or 97.5 percent of the total area of the county, is included in farms, of which 267,086 acres are in cropland and plowable pasture, 3,148 acres in woodland pasture, 319,372 acres in other pasture, 2,246 acres in woodland not pastured, and the remaining 16,282 acres in land used for other purposes.

Corn has been the main crop since farming began and, together with beef and game, was the chief food of the early settlers. The first farmers were not familiar with local climatic conditions and soil requirements, and they experienced considerable hardships. Farming methods were crude and wasteful. Insects and a series of dry years, culminating in the disastrous droughts of 1893 and 1894, caused many of the early settlers to leave the county, and agricultural development was greatly checked. The farmers who remained acquired larger holdings and gradually adjusted their system of farming to local conditions. As agriculture became more stable, wheat, oats, rye, and barley were grown.

Table 2, compiled from reports of the Federal census, shows the general trend of agriculture during the last 55 years.

TABLE 2.—*Acreage of the principal crops in Frontier County, Nebr., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1934 [1]
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Corn						182,907	49,936
For grain	419	72,938	105,302	133,445	103,475	155,362	879
For silage, fodder, or hogged off					[2] 11,163	27,545	19,057
Wheat	94	15,676	49,453	37,609	63,343	24,609	16,787
Oats	8	10,880	3,896	19,988	7,234	6,723	98
Barley	36	197	829	1,658	4,352	6,678	838
Rye	33	1,261	4,167	2,027	3,584	355	40
All hay	1,077	17,364	17,640	31,821	28,255	20,130	[3] 20,560
Alfalfa			1,348	3,878	2,049	1,891	1,979
Clover				51	33	1,129	263
Grains cut green			762	215	937	733	691
Other tame hay			4,023	8,365	6,219	4,966	[4] 2,542
Wild hay			11,507	19,312	19,017	11,411	
Sorghums for silage, hay, and fodder					[2] 21,230	11,350	15,085

[1] Year of severe drought.
[2] For forage only.
[3] Includes sorghums for silage and fodder.
[4] Includes wild hay.

Corn, wheat, and wild hay are the principal crops at present. Minor crops include oats, barley, rye, millet, alfalfa, kafir, sorgo, and sweetclover. Sorgo, locally called cane, is grown most extensively in the western part of the county.

The average yields of the principal crops for the period 1911 to 1933, inclusive, as recorded in the Nebraska Agricultural Statistics for 1933, are given in table 3.

TABLE 3.—*Average acre yields of the principal crops in Frontier County, Nebr., 1911–33*

Year	Corn	Winter wheat	Barley	Rye	Oats	Wild hay	Alfalfa	Sorghum forage
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Tons*	*Tons*	*Tons*
1911	5.0	9.0	8.8	7.5	11.5	-------	3.0	-------
1912	15.0	7.3	-------	-------	16.6	-------	3.0	-------
1913	5.1	15.0	13.0	14.0	22.5	-------	2.2	-------
1914	17.0	15.7	23.0	15.4	27.6	1.8	3.6	-------
1915	28.9	24.2	31.8	20.7	40.7	1.5	2.9	-------
1916	16.8	26.6	29.2	21.5	33.2	1.2	2.5	-------
1917 [1]	15.0	9.0	25.0	10.0	22.0	.9	2.7	-------
1918	20.0	8.0	14.0	8.0	11.0	1.0	3.3	-------
1919	19.0	15.0	23.0	14.0	27.0	1.2	2.8	-------
1920	26.0	14.0	28.0	16.0	32.0	.9	3.0	-------
1921	15.0	13.0	25.0	15.0	26.0	.8	2.2	2.7
1922	12.0	8.0	10.0	8.0	10.0	.6	1.9	2.0
1923	35.0	5.0	29.0	11.0	31.0	1.1	2.6	3.3
1924	20.0	14.0	21.0	14.0	21.0	.7	2.3	2.5
1925	17.0	13.0	15.0	11.0	18.0	.7	2.5	2.6
1926	5.0	6.0	8.0	6.0	7.0	.7	2.2	1.8
1927	28.0	15.0	28.0	17.0	30.0	1.1	2.4	2.9
1928	25.0	18.0	30.0	16.0	34.0	1.2	2.6	2.6
1929	12.0	12.0	22.0	13.0	26.0	1.0	2.8	2.5
1930	30.0	20.0	31.0	20.0	34.0	1.2	3.2	2.9
1931	20.0	19.0	18.0	17.0	25.0	.7	1.8	1.9
1932	8.0	7.0	15.0	10.0	19.0	.7	2.1	1.4
1933	22.0	-------	-------	-------	-------	-------	-------	-------

[1] Estimated.

According to the Federal census report for 1930, the value of field, orchard, vegetable, and farm-garden crops in 1929 was $1,850,094, of which the value of cereals was $1,498,327 and of hay and forage was $319,972. Domestic animals were valued at $2,996,213, and dairy products that were sold, at $248,468. The value of poultry raised and eggs produced was $335,166.

As in other counties of south-central Nebraska, the growing of grain and the raising and fattening of livestock are the principal sources of income. Most of the crops, except wheat, are fed to cattle and hogs, especially on farms operated by owners. The number and value of livestock on the farms during Federal census years is given in table 4.

TABLE 4.—*Number and value of livestock on farms in Frontier County, Nebr., in stated years*

Livestock	1890 [1]	1900		1910		1920		1930		1935 [1]
	Number	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*
Cattle	21,192	25,790	$1,401,548	31,691	$673,463	42,636	$2,138,782	40,960	$1,964,642	35,177
Horses	8,373	11,492		13,643	1,272,627	13,518	830,413	10,051	419,357	8,105
Mules	552	637		1,120	110,882	1,146	95,973	1,118	63,108	727
Swine	55,569	55,599		28,004	253,706	28,878	592,062	43,355	532,361	21,895
Sheep	217	147		903	5,797	1,227	14,026	2,370	16,050	517
Poultry	121,120	100,475	28,849	104,991	40,459	134,728	104,594	[2] 121,475	[2] 91,106	[2] 109,370

[1] Value not reported. [2] Chickens only.

The raising of cattle is the most important branch of the livestock industry. Most of the cattle are Herefords. Aberdeen Angus cattle are raised on several farms, and there is one large herd of Shorthorns in the county. Most of the cattle are of native stock, but some farmers ship in cattle for summer grazing, and some purchase animals for winter fattening. The cattle are fed corn and hay for a

period of 60 to 90 days, after which they are shipped to Omaha or Kansas City markets.

Hog raising ranks next in importance to the production of cattle. Most farmers raise from 20 to 60 hogs a year, and a few maintain herds of several hundred. Nearly all of these animals are fed corn and alfalfa, although young pigs usually receive some oats or barley. Poland China and Hampshire are the leading breeds, and many of the herds are purebred. Practically all of the hogs are fattened on the farms where raised, and most of them are sold in Omaha.

From 50 to 75 chickens are raised on most farms, and flocks of several hundred are maintained by many farmers. The principal breeds are Plymouth Rock, Leghorn, and Rhode Island Red. Poultry products are either sold or exchanged for farm supplies in the local towns.

Horse raising is confined to the breeding of work mares. Purebred stallions are kept on a few farms. Owing to the increased use of tractors in this and neighboring counties, the raising of colts on a commercial scale is no longer profitable.

Dairy products are becoming an important source of income, and most farmers milk from 3 to 10 cows, chiefly of mixed dairy and beef breeds. There are several purebred herds of Holstein-Friesians and Guernseys in the county. The surplus dairy products are sold at local cream stations, from which they are shipped to creameries in the large cities.

The Federal census reports 1,401 farms, with an average size of 434.1 acres, in 1935. There are a few small farms, but many include 1,000 acres or more. The average size has increased since 1900, when it was 352.4 acres.

Owners operated 50.8 percent, tenants 49 percent, and managers 0.2 percent of the farms in 1935. The number of tenant farms has increased steadily since 1900, when only 34 percent of the farms were operated by tenants. Share and cash systems of rental, and a combination of the two, are practiced. The share system is most popular. Under it the owner receives from one-third to one-half of the grain and from 50 to 75 cents an acre for use of the pasture land. Seed, labor, and machinery are furnished by the tenant.

Most of the farm buildings are kept in good repair, and many of the houses are equipped with modern conveniences. The farms are fenced, mainly with barbed wire, although some are enclosed with hog-tight woven-wire fencing. Nearly all of them are equipped with modern machinery. The Federal census reports 1,412 automobiles, 341 motortrucks, and 337 tractors on the farms in 1930. The work animals are mostly heavy draft horses, chiefly of Belgian breeding.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers, or horizons, called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone

are noted. The reaction of the soil [2] and its content of lime and salts are determined by simple tests.[3] Drainage, both internal and external, and other external features, such as relief, or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics, soils are grouped into mapping units. The three principal ones are (1) series, (2) type, and (3) phase. Areas of land, such as coastal beach or bare rocky mountainsides that have no true soil, are called (4) miscellaneous land types.

The most important group is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names corresponding to those of places or geographic features near which they were first found. Thus, Holdrege, Hall, Colby, Bridgeport, and Laurel are names of important soil series in this county.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus, the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Bridgeport very fine sandy loam and Bridgeport silt loam are soil types within the Bridgeport series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the soil unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type, which differs from the type in some minor soil characteristic that may have practical significance. Differences in relief, stoniness, and the degree of accelerated erosion are frequently shown as phases. For example, within the normal range of relief for a soil type, there may be areas that are adapted to the use of machinery and the growth of cultivated crops and others that are not. Even though there may be no important difference in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such an instance the more sloping parts of the soil type may be segregated on the map as a sloping or a hilly phase. Similarly, soils having differences in stoniness may be mapped as phases, even though these differences are not reflected in the character of the soil or in the growth of native plants.

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[2] The reaction of the soil is its degree of acidity or alkalinity, expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

[3] The total content of readily soluble salts is determined by the use of the electrolytic bridge. Phenolphthalein solution is used to detect a strong alkaline reaction.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS AND CROPS

Frontier County is in a section where the mean annual precipitation is little above the minimum required for profitable farming and where soil moisture is the limiting factor in determining the productivity and the use capability of the land for crops. Slightly more than 40 percent of the county is under cultivation, and most of the rest is used for native pasture or hay land. The uncultivated areas are chiefly on nonarable steep or severely eroded valley slopes and in strips on the flood plains, that are either too poorly drained, narrow, or dissected for farming.

The cultivated land, which occurs more or less extensively in nearly all parts of the county, ranges from nearly level to rolling, and probably 95 percent of it is suited for farming with tractors. It is used for the production of all the crops commonly grown in this section, chief among which are corn, wheat, oats, sorgo, barley, rye, alfalfa, and sweetclover, ranking in acreage, during most years, in about the order named. Millet, potatoes, and garden crops are also grown but are of less importance. Grain and tame hay are produced rather indiscriminately on all the cultivated soils, but the proportionate acreage devoted to a given crop differs in the various sections. Corn and alfalfa, both of which require an abundance of moisture for optimum growth, occupy a larger proportion of the bottom lands than of the uplands or terraces. Wheat, barley, and oats, which have a tendency to produce a rank vegetal growth at the expense of the grain when grown on the moist bottom lands, are produced almost entirely on the uplands and terraces, and sorgo, which can adapt itself to prolonged periods of drought, is grown principally on the uplands.

Although corn occupies the leading acreage on all the arable soils, principally because it is needed for feed, it is not so well adapted to this section of Nebraska as wheat, owing to the low rainfall, and yields of corn are more variable than those of wheat. Were it possible to produce another crop of equal feeding value, corn would be grown much less extensively.

More than 90 percent of the soils of the county have developed on loess, a light-gray limy and floury silt which covers the greater part of the total area and which is remarkably uniform in its physical and chemical properties. Throughout a few square miles of uplands in the western part of the county and strips of various widths in the valleys of Red Willow and Medicine Creeks, the soils are formed on sand or mixtures of loess and sand.

Frontier County is in the Great Plains region of the United States, where the native vegetation consists almost entirely of grasses. All the soils that are not severely eroded or have not developed from unstable or recently deposited and light-colored parent materials, have accumulated enough well-decomposed grass remains to give them dark-colored surface soils. The intensity of darkness in the surface soil is not so pronounced as in the soils of more eastern counties of Nebraska,

where, owing to a higher precipitation, the grass growth has been more luxuriant, its decay more rapid, and decomposed grass remains have accumulated in larger quantities. Nevertheless, the surface layers of all well-developed soils in this county are dark, in most places ranging from dark grayish brown to very dark grayish brown. Locally, they are almost black, especially when wet.

In addition to the dark color of their surface soils, most of the soils are friable throughout, have high moisture-retaining powers, contain an abundance of lime at a slight depth, and are easily penetrated by air, moisture, and plant roots. These features, however, are not equally developed. Differences in the character of the parent soil materials, in the length of time these materials have been exposed to weathering, and in the relief and drainage conditions under which the soils have formed, have prevented uniformity, not only in characteristics of the profile, but also in the producing capacity and crop suitabilities of the different soils. Throughout the more nearly level parts of the loessial uplands, more moisture enters the ground, and the soils have been leached of their lime to a greater depth than in the rolling and hilly parts. Erosion has been less severe, and the surface soils are thicker and darker colored than in hilly areas. In scattered depressions throughout the uplands, water accumulates after rains, and the soils have been leached of their lime to a great depth. From some of the steeper slopes, the dark surface soil has been almost or entirely removed, and the soils are light colored and limy from a point near the surface downward.

Although the soils of this county differ in their producing powers and suitability for crops, they may be placed in groups, each of which includes soils that are fairly uniform in agricultural value and are used for some particular crop or crops more extensively than are soils belonging to another group. In this county four groups, based on soil characteristics and other features that affect agriculture, are recognized, namely, (1) well-drained soils of the uplands and terraces, (2) excessively drained soils of the uplands, (3) poorly drained soils of the uplands and terraces, and (4) variably drained soils of the bottom lands.

In the following pages the individual soils of the different groups are described, and their crop adaptations are discussed. The soil map accompanying this report shows the distribution of the soils throughout the county, and table 5 gives their acreage and proportionate extent.

TABLE 5.—*Acreage and proportionate extent of the soils mapped in Frontier County, Nebr.*

Type of soil	Acres	Percent	Type of soil	Acres	Percent
Holdrege silt loam	266,816	42.8	Anselmo loamy fine sand	192	(1)
Holdrege silt loam, slope phase	768	.1	Valentine fine sandy loam	960	0.1
Keith very fine sandy loam	4,608	1.0	Butler silty clay loam	384	(1)
Hall silt loam	6,912	1.1	Laurel silt loam	6,272	1.0
Bridgeport silt loam	6,144	1.0	Laurel very fine sandy loam	5,248	1.0
Bridgeport very fine sandy loam	2,112	.1	Sarpy very fine sandy loam	15,808	2.5
Colby silt loam	38,016	6.1			
Colby silt loam, broken phase	269,312	43.2	Total	624,000	
Anselmo very fine sandy loam	448	(1)			

(1) Less than 0.1 percent.

WELL-DRAINED SOILS OF THE UPLANDS AND TERRACES

The soils of this group occupy about 80 percent of the cultivated land in the county, exclusive of that on valley floors. They cover all the terraces and occur throughout the uplands wherever the land is not poorly drained, sandy, or severely eroded. Corn is grown on about 65 percent of the farmed area, wheat on about 10 percent, oats on about 5 percent, and barley on about 3 percent. The rest is used largely for the growing of sorgo and sweetclover, and a variety of minor crops. The proportionate acreages devoted to the different crops on the individual soils of the group are not the same.

These soils are friable, contain considerable lime, have high moisture-retaining powers, and are easily penetrated by roots. They include the Holdrege and Keith soils of the uplands and the less extensive Hall and Bridgeport soils of the terraces. They all return higher average yields than those obtained on any soil of the other groups, except a few of those on the bottom lands. They differ among themselves, however, in their producing powers, owing chiefly to differences in their surface features and in the lay of the land, particularly with respect to higher and lower levels. The Holdrege and Keith soils have less even relief, as a rule, than the Hall and Bridgeport soils, and they suffer greater loss of moisture through run-off. Consequently they are a little less productive than the soils on the terraces, which receive much of the run-off from higher land.

The Holdrege, Keith, and Hall soils have developed from the gray limy and floury loess which covers most of the county. Their surface soils range from 8 to 12 inches in thickness, and, owing to the abundant supply of organic matter, they are dark grayish brown or very dark grayish brown. Their grayish-brown or grayish-yellow subsoils are composed largely of loose floury silt. The Bridgeport soils are developing from somewhat more recently deposited mixtures of loess and fine sand. They are less maturely developed and have slightly lighter colored surface soils than do the other soils of this group.

Holdrege silt loam.—Holdrege silt loam has a surface soil of very dark grayish-brown mellow silt loam from 8 to 14 inches thick. It is well supplied with organic matter which, in virgin areas, constitutes about 3 percent by weight of the topmost 6 inches and is an important factor in producing the soft mellow character that makes the soil so easy to till. The upper subsoil layer reaches a depth of about 32 inches and consists of grayish-brown silty clay loam which is moderately hard when dry but friable when moist. The color becomes lighter with depth, as the content of organic matter decreases. This is the heaviest layer of the profile, but its increased density is scarcely noticeable except through close comparison with that of the other layers. The lower part of the subsoil is light grayish-brown friable silt with a high content of lime. It rests on the parent Peorian loess, an almost white floury limy silt, at an average depth of 4 feet.

Holdrege silt loam is remarkably uniform in its characteristics on the smoother parts of the loessial uplands. On gently sloping areas, where there is more run-off, some of the surface soil has washed away, and lime is nearer the surface than is typical. The upper subsoil layer is a trifle heavier on the flats than on the slopes, and the surface layer in the western part of the general area occupied by this soil, near areas of Keith soils, is slightly lighter in color than in the

eastern part of the county. These variations are of little agricultural significance, and areas in which they occur are not shown separately on the soil map.

In the north-central part of the county, at the heads of small drainageways, are several small bodies which would have been mapped as a colluvial phase of Holdrege silt loam had they been larger. In these, the dark soil material has been washed from higher levels and deposited on the lower slopes, thus increasing the thickness of the surface soil in the latter situations. The colluvial deposits receive run-off from higher lying land and give slightly higher crop yields than are obtained on typical Holdrege silt loam. The subsoil is similar to the normal Holdrege subsoil.

Holdrege silt loam is the second most extensive soil and the most important agricultural soil in the county. It occupies nearly all of the nearly level or gently rolling parts of the loess-covered uplands, except small widely scattered and poorly drained basins occupied by the Butler soil and a narrow belt of Keith very fine sandy loam at the western edge of the county. Throughout most of its occurrence, the slopes are less than 4 percent, and practically none of them exceed 7 percent.

All this land can be farmed with tractor-drawn machinery. It absorbs water readily, has a high water-holding power, and is sufficiently friable to afford good aeration, easy penetration of roots, and free upward and downward movement of moisture. Lime is everywhere within easy reach of crop roots.

Although this soil is admirably suited for the growing of all crops common to the general region, it occurs on the uplands where soil moisture depends entirely on the precipitation, and its producing capacity varies considerably from year to year, according to differences in the amount of moisture it receives. In unusually wet seasons, crop yields, particularly those of corn, are about twice as large as those obtained in years of normal rainfall. In very dry years, the corn crop may fail. The demand for corn as feed for livestock necessitates using about 60 percent of the soil for this crop. Sorgo and kafir, which are able to withstand considerable drought, generally do well, even in the driest years. Alfalfa, if a good stand is obtained, returns fair yields as long as it is able to obtain moisture from the underlying loess. In the course of 3 or 4 years, however, this crop exhausts the deep-seated moisture supply and becomes unprofitable because it cannot make good growth on the precipitation alone. Sweetclover, which requires less moisture, yields higher than alfalfa on this soil, and in recent years is being grown more extensively Yields of wheat differ less from year to year than do those of most other crops, chiefly because wheat matures early in the summer before the moisture stored in the soil during the winter or spring is exhausted. Oats and barley also yield rather consistently. The soil and climate are a little better suited for the production of small grains than for the growing of corn and forage crops, and, because wheat is the chief cash crop of the county, a large acreage is devoted to it.

In numerous localities, this soil is being cultivated too close to the heads and edges of narrow almost vertical-walled canyons which, in places, extend into the Holdrege silt loam areas for a distance of several miles. Such cultivation facilitates increased erosion in the

vicinity of the canyons which should be kept surrounded by prairie sod for a distance of at least 20 feet on all sides.

Holdrege silt loam, slope phase.—The slope phase of Holdrege silt loam differs from typical Holdrege silt loam mainly in having a thinner surface soil. Most of it occupies slopes ranging between 7 and 10 percent. Run-off is more rapid on the slopes than on the flat upland, and less water enters the ground. Erosion has been more severe, and more of the dark-colored surface soil has been washed away. This layer, however, is at least 8 inches thick in most places, and it has been entirely removed in only a few places. The subsoil differs little from that of the typical soil.

This soil occupies small areas and narrow strips in the southern and central parts of the county, on slopes along Dry Creek south of Freedom and along several smaller drainageways. It all adjoins areas of typical Holdrege silt loam. None of the land is too steeply sloping for cultivation, and most of it is used for the production of the same crops as those grown on the typical soil. Owing to its thinner surface soil, its more sloping relief, and a greater loss of moisture through run-off, the sloping soil gives slightly lower yields than those obtained on the smoother typical soil.

Keith very fine sandy loam.—Keith very fine sandy loam differs from Holdrege silt loam in having a slightly lighter colored and coarser textured surface soil. The distinction between the Keith and the Holdrege soil is based largely on the color of the surface soil. As the luxuriance of the grass cover decreases from east to west in accordance with a decrease in the precipitation, the quantity of black organic matter incorporated in the surface soil becomes lower, and the color of this layer changes from very dark grayish brown, so characteristic of the Holdrege soils, to what may be described as dark grayish brown or chestnut brown, the normal color of the Keith soils. This change is so gradual that it is imperceptible within a distance of many miles. The variation in the amount of organic matter accumulated and the decided differences in color over great distances, however, necessitate a separation between these two soils even though the boundary line cannot be placed with certainty within a distance of several miles. In this county, the line between the two soils is arbitrarily placed where a change in texture also takes place, although a very fine sandy loam texture is not a peculiar feature of the Keith soils.

The surface soil of Keith very fine sandy loam, to a depth ranging from 7 to 15 inches, is dark grayish-brown friable mellow very fine sandy loam well supplied with organic matter. The subsoil, which continues to a depth of 3½ or 4 feet, is grayish-brown crumbly and friable heavy silt loam or silty clay loam in the upper part and gives way to grayish-brown limy and floury silt loam below. Both surface soil and subsoil have high moisture-retaining powers. Beneath the subsoil is very light yellowish-gray or almost white loose floury silt, from which the soil has developed. The soil throughout is sufficiently porous to allow good aeration, easy root penetration, and free upward and downward movement of water.

Keith very fine sandy loam occurs only in a few small bodies with a combined area of 7.2 square miles, on the loessial uplands in the extreme western part of the county. The relief is nearly level or gently undulating, the maximum slope being about 5 percent.

Owing to a small content of sand in the surface soil, this soil can be cultivated under a wide range of moisture conditions without injuring its tilth. Nearly all of the land is under cultivation. It is as productive as Holdrege silt loam, and the same crops, in about the same acreage ratios, are grown on it as on that soil.

As with Holdrege silt loam, this soil is being cultivated too close to the canyons which extend into and across the areas in which it occurs. All the land immediately adjoining the canyons should remain in virgin sod, in order to retard their extension.

Hall silt loam.—Hall silt loam occurs on terraces along the larger streams of the county. It differs little in profile features from Holdrege silt loam. The surface soil is very dark grayish-brown friable and mellow silt loam from 12 to 16 inches thick. In places it contains a little more sand than is typical and approaches a very fine sandy loam in texture. The subsoil is lighter in color and a trifle heavier than the surface soil. It is limy below a depth of 3 feet, and it rests, below a depth of about 4 feet, on silty water-laid sediments which were deposited when the streams were flowing at higher levels.

This soil is rather uniform throughout most of its distribution in the county, but in some places it is underlain, at a depth ranging from 1½ to 5 feet, by older buried soils that evidently were formed prior to deposition of the sediments on which the present soil has developed. This buried soil seems to have no agricultural significance, and areas in which it occurs are not shown separately on the soil map.

Owing to its terrace position, all the soil receives some moisture through run-off from land at higher levels. The land is nearly flat, and a large proportion of the moisture soaks into the ground. Both surface drainage and underdrainage are good.

Hall silt loam occurs chiefly along Medicine, Plum, Deer, East Muddy, West Muddy, and Red Willow Creeks.

This soil is not very extensive, but it is the most desirable soil in the county for general farming. Practically all of it is under cultivation. Corn and wheat are the principal crops. Some alfalfa is grown, chiefly along Red Willow Creek, where the water table is within reach of its roots. Corn and wheat yields are higher than those obtained on any other soil in the county, except some of those occupying well-drained positions on the bottom lands.

Bridgeport silt loam.—Bridgeport silt loam is the second most extensive soil on the terraces. The 12- to 15-inch surface soil is dark grayish-brown mellow friable silt loam fairly well supplied with organic matter. Below this the profile, which extends to a depth ranging from 4 to 5 feet, remains silty and friable but is practically devoid of organic matter and is light grayish brown or almost white. Lime, in finely divided form, is abundant a short distance beneath the surface of the ground.

This soil is fairly uniform throughout the greater part of its distribution in this county. In some small areas, however, the subsoil is a little heavier than is typical for Bridgeport silt loam and approaches the subsoil of Hall silt loam in general character.

Most of this soil occurs in long strips along Plum and Deer Creeks, and in small areas along Medicine, East Muddy, West Muddy, and Red Willow Creeks. It has developed largely from silty sediments deposited by the streams when their channels were near the present terrace levels. Colluvial material, washed down from nearby upland

soils, has contributed to it. The terraces on which this soil occurs lie from 15 to 35 feet above the stream channels and, for the most part, are lower than those occupied by Hall silt loam. The relief ranges from nearly level to gently sloping, the more sloping areas lying near the bases of upland slopes, where sediments from higher lying soil have accumulated.

Bridgeport silt loam is immaturely developed and has not accumulated quite so much organic matter as have the Hall and Holdrege soils. Consequently its nitrogen supply is somewhat lower. This deficiency, although reflected in slightly lower yields, is not sufficiently pronounced to reduce appreciably the agricultural value of the soil. Most farmers consider Bridgeport silt loam slightly inferior to Hall silt loam for farming purposes but equal to or better than some areas of Holdrege silt loam, because it is more favorably situated to receive water from higher levels. About 95 percent of the land is under cultivation.

The same crops, in about the same acreages, are grown on this soil as on the slightly darker colored soils of the uplands and terraces. Some areas of Bridgeport silt loam in the Medicine Creek Valley are underlain by a water table sufficiently near the surface for alfalfa to obtain a considerable part of its moisture from this source. Along Plum, East Muddy, West Muddy, and Deer Creeks, the water table is far below the level of the terraces, and little alfalfa is grown.

This soil has a high moisture-holding and a fairly high infiltration capacity. It contains sufficient organic matter to facilitate good tilth under a wide range of moisture conditions and is not subject to more than normal erosion.

Bridgeport very fine sandy loam.—Bridgeport very fine sandy loam differs from Bridgeport silt loam mainly in having a slightly higher sand content and a slightly lower organic-matter content in its surface soil. The surface soil is dark grayish-brown friable very fine sandy loam containing, in most places, considerable silt and organic matter. The remainder of the profile, where typically developed, is similar to the corresponding part of Bridgeport silt loam. It is very limy below a depth ranging from 18 to 24 inches. The most important variation in the profile occurs on some of the lower terraces, where the subsoil contains a larger proportion of sand than is typical, in places attaining a loamy very fine sand texture.

Bridgeport very fine sandy loam is not very extensive. It occurs principally in small areas along Medicine and Deer Creeks, and a few small bodies are along West Muddy, East Muddy, Red Willow, and Elder Creeks.

The relief is similar to that of the other soils occupying terraces. Most of this soil lies closer to the stream channels than do the silt loam members of the Hall and Bridgeport series, and it receives more wind-blown sand from the bottom lands. The slightly higher sand content of the surface soil enables it to absorb moisture more rapidly than do the silty soils, but the sand is not sufficiently abundant to noticeably reduce the stability or water-holding capacity of the surface soil.

About 85 percent of this soil is under cultivation. The rest, including small irregular-shaped areas, is left with its native cover of buffalo and grama grasses and is included in grazing land. The cultivated areas are used for the growing of all the crops common to

this section, although corn and alfalfa occupy the leading acreages. In dry seasons, the yields are as high as or higher than those obtained on Hall silt loam, but in normal or wet seasons, they are a little below those on that soil, chiefly because of the lower organic-matter content of Bridgeport very fine sandy loam. Corn yields are higher than those obtained on the Holdrege or Keith soils, but yields of small grains are a little lower. Alfalfa generally does exceptionally well on this soil, especially along Red Willow and Plum Creeks, where it is able to obtain some moisture from the water table. Good yields of sweetclover and sorgo are obtained also.

This soil is not subjected to more than normal erosion, except along streams where the banks sometimes erode during periods of high water. It can be cultivated under almost any moisture conditions without serious injury to its tilth.

EXCESSIVELY DRAINED SOILS OF THE UPLANDS

This group includes the Colby, Anselmo, and Valentine soils, all which are prevailingly light in color and low in organic matter. The Colby soils suffer excessive loss of moisture through run-off, and the Anselmo and Valentine soils lose at least a part of their moisture through downward seepage. The area occupied by the soils of this group has a wide range of topographic and soil characteristics. The Colby soils, which are the most extensive, rest on light-gray floury and limy silt similar to that underlying the Holdrege and Keith soils, but they occur in steeply sloping, hilly, and broken areas, where erosion is very severe. Most of them either have failed to develop a good surface soil or have lost all or most of this layer subsequent to its development.

The Anselmo soils are on a mixture of sand and silt, in transitional areas between the sand hills and the loessial uplands, on which dark-colored Holdrege and Keith soils have developed. Most of them have moderately dark though rather thin surface soils. The Valentine soils are composed largely of sand, the topmost few inches of which are slightly darkened by organic matter. All the sandy soils are near the western edge of the county.

About 90 percent of the area occupied by the soils of this group is used for native pasture or hay land. Most of the Colby soils occur in areas too rough for farming, and the Valentine soils, as a whole, are too unstable for the profitable production of grain and tame hay. The cultivated land is largely confined to the more gradual slopes of the Colby areas and to the Anselmo soils.

Colby silt loam.—Throughout most areas of Colby silt loam the surface layer ranges in color from light grayish brown to dark grayish brown and in thickness from 2 to 6 inches. The material in this layer ordinarily is loose and friable but becomes moderately compact if worked when wet. In most places the surface soil contains a moderate supply of organic matter, but this decreases rapidly with depth and practically disappears below a depth of 10 inches. The surface soil rests almost directly on the light grayish-yellow or almost white floury and limy silt of the parent loess.

Some variations from the typical soil occur. In a few places, the surface soil contains a higher proportion of very fine sand than typical and approaches a very fine sandy loam in texture. In many places, adjacent to areas of the Holdrege or Hall soils, the surface

layer is 3 or 4 inches thicker than typical. The color and thickness of this layer everywhere depend on the relief and on the extent of erosion to which the soil has been subjected. The surface soil is thickest on the more gradual slopes, where conditions have been most favorable for deep soil development and the accumulation of organic matter, and it is thinnest on the steeper slopes, shoulders of hills, and crests of ridges, where in places it has been removed by erosion. The variations, although numerous are of little agricultural importance and of such a patchy character that it is not practical to show them on the soil map.

Colby silt loam occurs in bodies of various sizes, but mainly small, scattered throughout nearly all parts of the loessial uplands, but it is most extensive in the northern half of the county where erosion has been most severe. The greater number of bodies range in size from 5 to 200 acres.

The relief in most places is gently sloping to strongly rolling and in this respect is intermediate between that in areas of the Holdrege and Keith soils, on the broader and smoother divides, and that in the extremely eroded and dissected areas of Colby silt loam, broken phase. Run-off is everywhere rapid, and erosion is serious on the steeper slopes, especially where the land is not properly managed. In many places, areas of Colby silt loam, broken phase, gradually are encroaching on areas of the typical soil.

Although the areas of Colby silt loam are considerably rougher than those of the Holdrege and Keith soils, practically all of this soil could be farmed, provided the land were carefully managed to conserve the moisture supply. Only about 35 percent of the soil is under cultivation, chiefly to corn, wheat, oats, sorghum, and sweetclover, ranking in acreage in the order named. Yields of corn and wheat are only a little below those obtained on the thicker and darker soils of the uplands, if measures are taken to conserve the moisture in the Colby soil. Sweetclover yields nearly as high on this soil as on any of the upland soils. Unless the cultivated areas of Colby silt loam are carefully managed, erosion rapidly removes the loosened surface soil, forms gullies, and renders the land nonarable.

The uncultivated areas of Colby silt loam are used chiefly for pasture land and, to some extent, for the production of native hay. Grass grows more luxuriantly on this soil than on the broken phase of Colby silt loam or on the Valentine soils.

Colby silt loam, broken phase.—Colby silt loam, broken phase, occupies 43.2 percent of the total land area of the county and includes 90 percent of the pasture land. It overlies loess identical with that underlying the Holdrege soils, but it has been subjected to such severe erosion that the accumulation of organic matter has been greatly restricted. The surface soil almost nowhere exceeds 4 inches in thickness, even in the less eroded areas. Throughout most of its distribution, the soil consists of light-gray silt, the topmost 2 or 3 inches of which has been darkened only slightly by organic matter. It is very limy throughout.

This soil is in all parts of the upland, wherever erosion has carved steep slopes and rugged relief in the loess. It occurs on the steeper sides of nearly all of the drainage courses and is extensively devel-

oped in the western tier of townships south of Plum Creek, also in the central part of the county.

Included with this soil on the soil map are small patches of rather gently sloping land, near the bases of slopes, and numerous narrow strips of alluvium on canyonlike floors. Most of these included areas are too small or to inaccessible for use for cultivated crops.

A variation of this soil occurs in the extreme western part of the county, where the land has received wind-blown sand from adjacent areas. Here the upper stratum of loess, of which this soil is so largely composed, contains some sand, and the soil is almost a very fine sandy loam. This variation does not differ sufficiently in agricultural value from the rest of the soil to warrant separation on the soil map.

Colby silt loam, broken phase, is topographically unsuited to cultivation, but it supports a good growth of prairie grasses, principally grama, buffalo, and little bluestem, with big bluestem on some of the narrow canyon floors and lower valley slopes. These grasses furnish good grazing from May to October, inclusive. The grasses do not grow quite so luxuriantly as on the darker colored soils of the county, but they have as high nutritive value. Some wild hay is produced on the less steeply sloping areas.

Anselmo very fine sandy loam.—The 2-inch surface layer of Anselmo very fine sandy loam is grayish-brown friable fine sandy loam or very fine sandy loam. The subsurface layer, which reaches a depth of 12 inches, is of similar texture but of slightly darker color. It contains enough silt and organic matter to bind loosely the sand grains, of which it so largely consists. The next lower layer, which is the upper part of the subsoil, continues to an average depth of 22 inches, and it is firmer and more coherent than any layer above or below. It is light grayish-brown heavy fine sandy loam or sandy silt loam and is friable throughout. Beneath this layer is pale yellowish-gray loamy very fine sand which is moderately firm in position but crushes easily. Below a depth of 32 inches the material is incoherent gray sand similar to that in areas of dune sand. Except in a few places, all lime has been removed to a depth of at least 8 feet.

Included with Anselmo very fine sandy loam on the soil map are several small bodies of Anselmo fine sandy loam. These bodies collectively occupy less than 100 acres and are not shown separately. They do not differ significantly in agricultural value from Anselmo very fine sandy loam. Most of them are in sec. 31, T. 8 N., and sec. 6, T. 6 N., R. 30 W. Some of them are extensions of larger bodies mapped in Hayes County to the west.

Practically all of Anselmo very fine sandy loam is in the western part of the county between areas of the extremely sandy Valentine soil and the silty soils of the loessial uplands. It occupies only a small total area. The largest developments are about 2 miles northwest of Pine Bluff High School.

The material from which this soil developed is a wind-blown mixture of sand and silt, derived, respectively, from the sand hills to the west and the loess section to the east. The relief is typical of wind-blown deposits and is characterized by shallow undulating swales, low rounded hummocks and ridges, and gentle slopes. Surface drainage and underdrainage are everywhere good. The soil absorbs practically all of the precipitation and holds most of the soil moisture until needed by the vegetation.

About 85 percent of the land is devoted to cultivated crops, chiefly corn which, in dry years, yields as high as on most of the finer textured soils. In wet seasons, however, the yields are below those obtained on the dark silty soils, largely because the sandy Anselmo soil has a comparatively low organic content and consequently a low supply of nitrogen. Rye and sweetclover do well, and oats give profitable yields in most years, but the land is a little too sandy for high returns from wheat and barley.

The soil is easily handled and can be cultivated under any moisture conditions without injury. It warms rapidly in the spring, and seed can be planted about a week earlier than on the heavier soils. Although the soil is sandy, it contains enough organic matter to insure stability against wind erosion, except during the most prolonged dry and windy spells.

Anselmo loamy fine sand.—Anselmo loamy fine sand differs from Anselmo very fine sandy loam mainly in having a slightly lighter colored, coarser textured, and less stable surface soil.

The surface soil is dark-brown or dark grayish-brown loosely coherent loamy fine sand ranging from 8 to 12 inches in thickness. It contains a moderate supply of organic matter. The subsoil is grayish-brown or grayish-yellow friable heavy sticky fine sandy loam or light loam, practically devoid of organic matter. Below a depth of 32 inches is incoherent pale yellowish-gray fine sand.

This soil is very inextensive. Most of it is along or near the western county line. The largest area is about 1½ miles southwest of Pine Bluff High School. The relief is undulating and is characterized by low rounded knolls and ridges, some of which are composed of almost pure sand. The soil lies somewhat lower and is more nearly level than Valentine fine sandy loam. Surface drainage has not been established, as all the precipitation sinks into the porous sandy material.

This soil is of little agricultural importance because of its small extent. It is more productive than the Valentine soil, however, and about 50 percent of it is under cultivation. Corn is the principal crop. Some sweetclover and grain sorghum are produced. Small grains are seldom grown, as the soil, where cultivated, drifts badly during dry, windy weather and frequently exposes the shallow root systems of these crops to drought. The uncultivated areas are about equal to the Colby soils for grazing purposes. Some of them are used for the production of wild hay.

Valentine fine sandy loam.—Valentine fine sandy loam has a 6- or 8-inch grayish-brown friable fine sandy loam surface soil containing enough organic matter, very fine sand, and silt to prevent excessive wind erosion under normal conditions. The rest of the soil profile consists of almost pure gray sand which is incoherent when dry and loosely coherent when wet. The soil has been thoroughly leached of its lime. Although the surface soil contains more fine material than does the corresponding layer of Anselmo loamy fine sand, it is no more coherent, as it contains less organic matter. The subsoil is much more sandy and less coherent than that of any Anselmo soil.

Valentine fine sandy loam occurs only in the extreme western part of the county and connects with an area of this soil in Hayes County.

The relief ranges from gently undulating to rolling. The smoother areas are modified, in most places, by scattered low rounded knolls,

hummocks, and ridges. Drainage, which is subterranean, is everywhere good. This porous soil absorbs all the precipitation as rapidly as it falls.

The fine sand of which this soil is so largely composed was released from the Ogallala sandstone of late Tertiary age. It has been so shifted by wind and water, redeposited, and subsequently weathered, that no trace of the source material remains.

About 50 percent of this soil is under cultivation. The rest, which supports a growth of big bluestem, little bluestem, sandgrass, and grama, is included in grazing and hay land. This soil is slightly less productive than Anselmo loamy fine sand, chiefly because of its lower organic-matter content and the looser, less coherent, character of its subsoil. Corn is the chief crop in the cultivated areas. Sweetclover and grain sorghums do well, provided good stands are obtained. Grain sorghum is better adapted to the soil than corn, as it is planted in denser stands which better control soil drifting. Practically no alfalfa is grown.

A few small bodies of Valentine sand occur within areas of this soil, chiefly on or near the Frontier-Hayes County line. Some of these bodies extend across the line, and their distribution in Hayes County is shown on the soil map of that county. Because of their small extent in Frontier County, however, they are not shown separately on the accompanying map. They occupy higher knolls and ridges than Valentine fine sandy loam, are composed of almost pure gray sand from the surface downward, and are suited only for grazing land.

POORLY DRAINED SOILS OF THE UPLANDS AND TERRACES

Butler silty clay loam.—Butler silty clay loam is the only poorly drained soil on the uplands and terraces in this county. It occupies basinlike depressions which have no surface drainage outlets. Storm water accumulates in the basins, where it often remains for several weeks, then disappears slowly through seepage and evaporation.

The 9-inch surface layer is very dark grayish-brown friable silty clay loam containing an abundance of organic matter. The rest of the surface soil, which extends to a depth of about 12 inches, is friable and silty but may or may not be dark. It invariably contains more or less gray silt or very fine sand particles, from which the organic matter has been leached, and in places these are abundant enough to give the material a pronounced gray shade. The surface soil abruptly overlies dense massive clay which is very dark grayish brown—in places almost black in the upper part. It becomes slightly lighter colored with depth. This, a true claypan, extends to an average depth of 4 feet, where it gradually gives way to light-gray friable silt or silty clay. Some lime occurs below a depth of about 5 feet, and the parent loess lies at a depth of about 6 feet.

Butler silty loam is not an extensive soil. The largest area is 2½ miles northeast of Maywood near Quimby School.

Poor drainage prevents cultivation except on about 35 percent of this land. In seasons of high precipitation the soil remains wet too much of the time to produce corn, the crop for which it is best suited. In normal years yields of corn on the better drained areas are nearly as large as those obtained on Holdrege silt loam. Wheat, oats, and alfalfa do fairly well in some areas which have been artificially

drained. Much of the land is so poorly drained that it is regarded as waste land, although hay of rather poor quality is produced on it in a few localities. A part of this soil could be drained by means of ditches, but most of the areas are too small to warrant much expense for drainage. This soil occupies only a small part of the farms on which it occurs and is of little agricultural importance in this county.

VARIABLY DRAINED SOILS OF THE BOTTOM LANDS

The soils of this group occupy the lowest positions in the county. They occur in strips and bodies of various sizes on the bottom lands, or flood plains, along all the larger and many of the smaller drainageways. They rest on rather recently deposited stream sediments. None of them has accumulated much organic matter or has been greatly altered by the soil-forming processes. The character of the sediments, therefore, is the dominant factor in determining the character of the soils. Most of the sediments came from light-colored formations; consequently the soils on the bottom lands are rather light colored.

The bottom lands slope almost imperceptibly down the valleys and toward the streams. There is little relief except that produced by slight elevations, shallow depressions, and old and active stream channels. Surface drainage, although rather slow, is well established, except in a few local depressions and in several areas at the heads of artificial lakes. Most of the bottom land lies from 3 to 10 feet above the stream channels, and the soils, as a whole, are well supplied with moisture, even during the drier years.

The group includes the Laurel and Sarpy soils. The first-named are developing on the finer textured more silty stream deposits and have slightly darker surface soils than the Sarpy soils which are on sandy sediments.

All the soils of this group are moister than soils of the uplands and terraces, because they receive, not only the precipitation, but also considerable water through run-off from higher levels and through capillarity from the water table. Much of the area occupied by them is in strips too narrow or too dissected by stream meanders to be used for cultivated crops, but most of the larger and better drained areas are farmed. Corn occupies the greater part of the cultivated land, although all crops suited to the climate are grown. The yields of corn, alfalfa, and sweetclover on these soils are higher than those obtained on any of the other soils in the county except during occasional years when all cultivated crops on the bottom lands may be seriously damaged by floods. Small grains also do well, except in wet seasons when they have a tendency to produce a rank vegetal growth at the expense of the grain and to mature rather late.

The uncultivated parts of the bottom lands remain in native pasture and hay land.

Laurel silt loam.—The 6- to 8-inch surface soil of Laurel silt loam is grayish-brown friable silt loam. It is underlain by a thin layer of slightly lighter colored and a trifle heavier silty clay loam. This gives way downward to grayish-yellow or almost white floury silt. Below a depth of 30 inches, the material generally is similar to the loess which underlies the well-drained soils of the uplands. Lime, in powder form, is mixed with the mineral soil particles throughout

the profile. The content of organic matter is only moderate, and most of it is in the surface soil.

Along Red Willow Creek, the subsoil of Laurel silt loam is mottled or splotched with rusty-brown and brown spots and splotches, caused by imperfect drainage. Here the water table often stands about 3 feet below the surface during normal seasons. In other places the subsoil is nearly uniform in color to a depth of more than 3 feet. In a few spots, the soil material rests on sand at a depth ranging from 3 to 4 feet. These variations are of such small extent that they are not shown separately on the soil map.

Only 9.8 square miles of this soil are mapped. Most of the areas occur in a more or less continuous strip along Medicine Creek from Stockville to the southern county line and along Red Willow Creek throughout its course across the county.

Areas of Laurel silt loam have little relief, except in places, caused by drainage courses. Along Red Willow Creek, the soil lies only from 3 to 6 feet above the bed of the channel, and the subsoil is imperfectly drained in places. Along Medicine Creek, it lies from 6 to 12 feet above the normal level of the stream and is well drained throughout.

The soil is everywhere better supplied with moisture than soils on the uplands and terraces, because the precipitation received by it is supplemented by run-off from higher land and in places by capillary moisture from the water table. Corn, alfalfa, and sweetclover are especially adapted to this soil and give higher yields than those obtained on any soil throughout the uplands and terraces, except during seasons when the bottom lands are flooded. In well-drained situations, small grains also produce high yields except in wet seasons, when these crops mature late and yield rather low.

In the past, crops have been lost by floods, but these instances are very rare. Approximately 90 percent of the land is cultivated, and the rest supports a luxuriant growth of grasses, with some narrow strips of trees adjacent to some of the stream channels.

Included with Laurel silt loam on the soil map are several small areas of dark-colored soil that would have been shown as Wabash silt loam had their size justified the separation. A strip of this soil lies along Plum Creek throughout most of its length in the county. Another area extends through the center of sec. 5, T. 8 N., R. 25 W. This included soil has a very dark grayish-brown mealy silt loam surface soil 12 or 14 inches thick, underlain by dark grayish-brown heavy but friable sticky silt loam to a depth of 3 feet or more. The surface soil is rich in organic matter, and the subsoil, as its color indicates, is not deficient in this material. No part of the soil profile is limy. The included soil differs from typical Laurel silt loam in that it contains no lime, is darker, and has a higher content of organic matter. The water table lies at a greater depth than in most areas of Laurel silt loam, but there is little or no difference in productivity between the two soils.

A poorly drained phase of Laurel silt loam occupies two small areas along Medicine Creek, near Maywood and Curtis, where the stream has been dammed to form artificial lakes. These areas, both of which are too wet for cultivation, are not sufficiently large to warrant being shown on a small-scale map. They are included in pasture and hay land.

Laurel very fine sandy loam.—Laurel very fine sandy loam differs from Laurel silt loam only in having a little more very fine sand in its surface layer. The surface soil is typically light grayish-brown pulverulent very fine sandy loam with a moderate content of organic matter. The subsoil is identical with that of the silt loam. This soil is intricately associated with Laurel silt loam, and areas of the latter, too small to indicate separately, are included with it on the soil map.

The principal developments of Laurel very fine sandy loam occur in narrow strips in the bottom lands along Medicine Creek and its larger tributaries. The largest strip extends along the creek, from Maywood to a point 5 miles southeast of Curtis.

Owing to the slightly higher sand content of its surface soil, this soil can be cultivated under a wider range of moisture conditions than Laurel silt loam. The sand is nowhere sufficiently abundant, however, to reduce the coherence or the water-holding capacity of the soil which has approximately the same productivity as the silt loam, except in places where it occurs along the smaller tributaries to Medicine Creek. Along these tributaries, the water table lies at considerable depth, and crops are not benefited so much from ground water as they are in the main valley of Medicine Creek, where most of Laurel silt loam occurs.

About 80 percent of Laurel very fine sandy loam is under cultivation, principally to corn, grain sorghum, and alfalfa. A luxuriant growth of grass covers the rest of the land. Many trees, mostly cottonwood, grow along the banks of the streams.

During years of normal or subnormal precipitation, this soil is more productive of corn and alfalfa than any of the soils on the uplands or terraces, but all crops are damaged more or less by occasional floods in wet years.

Sarpy very fine sandy loam.—The surface soil of Sarpy very fine sandy loam consists of grayish-brown friable very fine sandy loam 6 or 8 inches thick. It is underlain by light-gray friable pulverulent very fine sandy loam of almost floury consistence to a depth of 3 feet or more. A small quantity of finely divided lime is thoroughly mixed with the mineral soil particles throughout the soil profile.

The principal variations in this soil are in the texture of the material in surface soil and subsoil. In some places the surface soil contains unusually large quantities of silt, and in other places fine and medium grades of sand are abundant. In one of the largest areas, which is along Medicine Creek between Curtis and Stockville, the subsoil, below a depth of 2 feet, is composed almost entirely of incoherent fine sand and very fine sand, and the soil as a whole does not contain so much organic matter as it does along the narrower drainageways, where more than 80 percent of it occurs.

The relief is negligible, except locally, where the land surface is modified by old and active stream channels, slight elevations, and shallow depressions. All the soil is subject to occasional overflow, but, except in a few places, water drains off rapidly when the streams subside.

Only about 35 percent of the land is cultivated. The rest occurs largely in strips too narrow for profitable farming. This soil is comparatively low in organic matter, and consequently in nitrogen, but its protected position and favorable moisture supply enable it to produce slightly higher yields of corn and alfalfa than are obtained on any of the soils of the terraces and uplands, except in seasons

when crops on the bottom lands are ruined by floods. It is not quite so productive, however, as the less sandy Laurel soils of the bottom lands. Part of the alfalfa seed planted fails to germinate in the somewhat unstable fine sand of the Sarpy soil, and it usually is necessary to sow a few more pounds of seed to the acre than is required on firmer ground. Sweetclover, although well adapted to this soil, is seldom grown, because alfalfa is preferred for feeding purposes. Some truck crops, chiefly watermelons and potatoes, are grown for consumption in the home and for sale in local markets.

Much of this soil occurs in strips so narrow or so dissected by stream meanders that farming is difficult. The uncultivated areas are used mostly for pasture and hay land.

LAND USES AND AGRICULTURAL METHODS

Farm-management practices and the methods of growing and harvesting the crops in Frontier County are similar to those throughout south-central Nebraska. As the farms are large compared with eastern farms, more modern and labor-saving machinery is used.

Corn, which is the principal crop, is planted in May, generally between the 1st and 15th. It is cultivated three times and receives no other attention until harvest. The greater part is husked from the standing stalks, after which cattle and horses are pastured in the fields during the winter. On a few farms equipped with silos, the corn from 15 or 20 acres is cut each year for silage. Many of the farmers annually fence off a few acres of unhusked corn for fattening hogs and cattle, thereby saving part of the expense of husking the crop. Corn is often grown on the same ground for several consecutive years without much change in yields. The better practice, however, is to rotate this crop with alfalfa or sweetclover and to grow considerable wheat, oats, and grain sorghum.

All the wheat grown is of the winter varieties. The land to be used for wheat is usually plowed and harrowed in late summer, and seeded in September. Many farmers drill the seed between corn rows. Wheat usually matures early in July, and most of it is cut with a binder, shocked, and later threshed, although some is harvested with a combine. Kanred, Turkey, and Nebraska No. 60 are the most popular varieties.

Oats are not considered a very profitable crop and have not been grown so extensively in the last 10 years as formerly. This crop is needed for horse feed and fits in rotations with corn very well. It is generally planted with a press drill and is harvested in the same manner as wheat, but the land is prepared and the grain is planted in the spring instead of the fall. Practically all of the crop is consumed by the work animals or young pigs, on the farms where produced. Smut occasionally lowers oat yields during periods of rainy and damp weather, but injury from this source can be controlled by killing the smut spores before the grain is planted. This may be done by sprinkling the seed with a solution containing 1 pint of formaldehyde to 35 gallons of water.[4]

[4] NEBRASKA UNIVERSITY, AGRICULTURAL COLLEGE EXTENSION SERVICE, DEPARTMENTS OF AGRONOMY AND PLANT PATHOLOGY. CEREAL SMUTS AND THEIR CONTROL. Nebr. Agr. Col. Ext. Cir. 126, 8 pp., illus. 1925.

Barley ranks third in importance among the small-grain crops, and its production has been increasing rather rapidly in the last 10 years. It is planted early in April at the rate of 2 bushels of seed an acre and is harvested in the same manner as wheat. Most of it is fed locally to hogs. Feeding tests show that coarsely ground barley is 90 percent as efficient as corn in a fattening ration. Barley could be grown more extensively, in order to insure feed should the yield of corn be materially reduced owing to unfavorable weather during late summer.

Rye is grown by only a few farmers. The seed is planted mostly in the fall, and the crop is used for hog feed, for hay, and for pasture. It is rarely plowed under for green manure.

Grain sorghum is the chief forage crop, and it is grown on nearly every farm throughout the uplands. Grain sorghums belong to a group of plants that become temporarily dormant during dry periods, and they are very resistant to drought. The best quality of feed is produced if the sorghum is cut when the earliest heads begin to mature. Most of it is fed with corn and barley. Its value as feed compares favorably with that of wild hay. Black Amber, Sumac, and Early Orange are the chief varieties of kafir grown.

Alfalfa and sweetclover are the leading tame-hay crops. Most of the alfalfa is produced on the alluvial soils, where there is an abundance of moisture. This crop does not produce good yields on the uplands, except during the first few years, as it rapidly depletes the deeply stored soil moisture and cannot make optimum growth on precipitation alone. In this section of Nebraska, alfalfa yields best in areas where the water table is within 8 feet of the surface. Thorough seedbed preparation is important in obtaining a good stand of this crop. Early plowing, followed by sufficient disking, harrowing, and possibly rolling to control the growth of weeds and to compact the soil, is desirable in most places. A stand of alfalfa usually is allowed to remain as long as it yields profitably. A field is rarely frozen out. Ordinarily three cuttings are made during the summer. The hay is fed chiefly to hogs and cattle.

Sweetclover is becoming an important crop, especially in the eastern part of the county where the rainfall is a little higher than it is farther west. It is grown in the same manner as alfalfa but fits into shorter rotations and is more resistant to drought. On the uplands its value in rotations is greater than that of alfalfa as it does not take as much moisture from the subsoil. The chief uses of sweetclover are for pasture and hay. The plant is a biennial and dies at the end of the second year after producing seed. It is inferior to alfalfa for feed, and, unless cut and cured at its optimum moisture content, it is rather coarse and unpalatable.

Wild hay is produced mostly on the level floors along the smaller drainageways and on the less eroded slopes of the uplands. The greater part comes from the poorly drained bottoms, although that produced on the uplands has the highest feeding value. Most of the wild hay is either stacked in the fields or stored in the barns for winter feeding. Only a small quantity is baled.

No commercial fertilizer is used. A considerable quantity of barnyard manure is available, but, in general, little care is taken to preserve it. On many farms it is piled outdoors where much of its value is lost through leaching. The manure is hauled in the fall or spring

and generally is spread on the smooth slopes of the uplands where the surface soil is thinnest. Some manure is used on vegetable gardens and on the Sarpy soil of the bottom lands. On tenant farms, little care is taken to apply the manure where it is most needed, and much of it is spread on the land nearest the barnyard.

Practically all of the soils have enough of the essential plant nutrients to produce higher yields than the precipitation allows. In years of high precipitation, yields are frequently more than twice those obtained in seasons of normal or subnormal rainfall. None of the yields is appreciably increased through the use of commercial fertilizer. On the uplands, barnyard manure may decrease crop production, especially during dry seasons, when the manure decomposes very slowly, prevents the soil from packing, and promotes the loss of moisture through evaporation. The plowing under of green-manure crops increases crop yields, but mainly to the extent that this practice adds to the soil-moisture supply. The control of the growth of weeds is much more important in this section than in places farther east. Throughout the uplands, the conservation of the available moisture is of primary importance.

PRODUCTIVITY RATINGS

The soils of Frontier County are classified in table 6 according to their ability to produce the more important crops of this general region. This classification compares the productivity of each soil for each of the leading crops in the county to a standard, namely 100, which is the rating given a soil that is inherently the most productive in the United States for the crop under consideration and which occupies sufficient acreage to warrant classing it as the standard soil for that crop. The rating, 100, is called the base index and is the standard with which the productivity of all other soils for any particular crop is compared. Thus, a soil estimated to be one-half as productive of a given crop as the one having the base index rating receives an index of 50.

TABLE 6.—*Classification of soil types in Frontier County, Nebr., according to*

Soil type [2]	Crop productivity index [3] for—									
	Corn	Oats	Wheat	Rye	Barley	Grain sorghum	Forage sorghum	Alfalfa	Sweetclover	Wi ha
Hall silt loam	55	65	60	60	65	65	60	60	60	
Bridgeport silt loam	55	65	60	60	60	65	60	60	60	
Bridgeport very fine sandy loam	55	65	60	60	60	65	60	60	60	
Laurel silt loam (well drained)	50	55	55	55	50	60	75	60	70	
Laurel very fine sandy loam (well drained)	50	55	55	55	50	60	75	60	70	
Holdrege silt loam	45	55	55	55	50	55	50	30	55	
Keith very fine sandy loam	45	55	55	55	50	55	50	30	55	
Holdrege silt loam, slope phase	40	50	50	50	45	50	45	25	50	
Sarpy very fine sandy loam (well drained)	45	50	50	50	45	55	60	55	65	
Anselmo very fine sandy loam	40	45	45	45	40	50	45	25	45	
Colby silt loam	25	35	30	30	25	35	40	15	25	
Anselmo loamy fine sand	20	------	------	25	------	30	35	------	25	
Valentine fine sandy loam	20	------	------	25	------	30	30	------	25	
Butler silty clay loam	------	------	------	------	------	------	------	------	------	
Laurel silt loam (poorly drained)	------	------	------	------	------	------	------	------	------	
Laurel very fine sandy loam (poorly drained)	------	------	------	------	------	------	------	------	------	
Sarpy very fine sandy loam (poorly drained)	------	------	------	------	------	------	------	------	------	
Colby silt loam, broken phase	------	------	------	------	------	------	------	------	------	

[1] This table has been prepared jointly by officials of the following organizations: Soil Survey Division, Bureau of Chemistry of Agricultural Economics, U. S. Department of Agriculture; and the University of Nebraska, Division of Conservation and Su

[2] Soils are listed in the approximate order of their productivity in the county, the most productive first.

[3] Soil types inherently most productive for the specified crop in the United States are given the index 100. Only those acreage in the more widely known crop regions are given this standard rating. The indexes in this table give the approximate

[4] This column shows the approximate number of days during the grazing season that 1 acre will support 1 cow without i County is 6 months.

NOTE.—No ratings on grain and tame-hay crops are given to soils that are generally unsuited to cultivation or are farmed on

The productivity indexes are based on the ability of the soil to produce under a management that is capable of maintaining the inherent or natural level of productivity but which does not involve irrigation, terracing, drainage, or the use of soil amendments other than those produced from crops grown on the soil.

The soils are listed in the order of their general productivity which is determined chiefly by their ability to produce the more important staple crops. No attempt is made to group the soils best suited for specified crops or to account for differences in the quality of the crops.

As the soils in this county receive no amendments, such as lime, phosphate fertilizer, and complete fertilizer, no rating is given to indicate their response to such fertilization. The use of manure produced on the land is not considered an amendment.

The factors influencing the productivity of the soils are mainly climate, soil characteristics, and relief, or lay of the land. As long-time crop yields [5] furnish the best available summation of the factors contributing to soil productivity, these were among the data used in determining the inherent productivity indexes given in table 6.

The rather low indexes given to some of the soils do not necessarily indicate that these soils are poorly suited for the crops grown on them. Many of the soils are among the strongest and most productive in this section. None gives as high yields of a particular crop as are obtained on what is regarded as the standard soil for that crop, but this, in most instances, is due mainly to less favorable moisture conditions and surface features, or both, than occur in the section occupied by the standard soil. Most of the soils in this county contain enough plant nutrients to insure higher yields were moisture more abundant.

For the soils on the bottom lands, or flood plains, two index ratings are given in table 6, one applying to the better drained areas and the other to poorly drained areas. The map, however, does not distinguish between these areas. Elsewhere on the bottom lands, the poorly drained tracts, although numerous, occupy such small patches and narrow strips that they cannot be indicated legibly on the map.

Streams occasionally overflow small local tracts on the flood plains, but no productivity ratings are given to these tracts because overflow is of little importance in the agriculture of the county.

Table 6 is not based on enough of the factors which influence land use to warrant interpreting the ratings directly into specific land values. It is based on essentially permanent factors relating to the inherent productivity of the soils, and no consideration has been given transitory economic factors. In some instances the information on which the ratings are based is not so complete as desired, and further study may suggest changes.

The following tabulation gives the more important crops of the county and the acre yield that has been set up as a standard of 100 for each crop. These yields represent long-time production averages

[5] Data on long-time yields for specific soils were collected by the field personnel during and subsequent to the survey. In addition, free use was made of unpublished estimates on average annual crop yields for the period 1923–32, supplied by the Bureau of Agricultural Economics, U. S. Department of Agriculture, cooperating with the Nebraska Department of Agriculture.

of the inherently most productive soils of significant acreage in the United States for products of satisfactory quality and are obtained without the use of soil amendments other than those produced directly or indirectly by the soil.

	Bushels
Corn (grain)	50
Oats	50
Wheat (all kinds)	25
Rye	25
Barley	40
Sorghums (for grain)	40

	Pounds
Alfalfa	[1] 8,000
Sweetclover	4,000
Wild hay	2,000
Sorghums (for forage)	8,000

	Cow-acre-days [2] per year
Pasture	100

[1] Since publication of the Soil Survey of Gosper County, Nebr., the standard yield used for alfalfa is 8,000 pounds instead of 9,000.

[2] Cow-acre-days is a term used to express the carrying capacity of pasture land. It is the number of days during the grazing season that 1 acre will support 1 animal unit without injury to the range. For example, a soil type able to support 1 animal unit per acre for 360 days of the year would rate 360, whereas another soil type able to support 1 animal unit per 2 acres for 180 days of the year would rate 90.

MORPHOLOGY AND GENESIS OF SOILS

Frontier County is situated approximately on the boundary between the zones of Chernozem and the Chestnut soils. Although the gradation from one zone to the other is imperceptible within short distances, a somewhat arbitrary line between the two is drawn in this county at the contact between the Holdrege and the Keith soils.

The more persistent common characteristics of the soils are those which result from the influence of the parent material and the climate. The differences in the soils, as well as their distribution, are, with few exceptions, due to differences in relief which controls the moisture conditions under which they developed.

The parent soil material throughout most of the uplands is light-gray floury and limy silt, known geologically as Peorian loess. It is presumably uniform in its physical and chemical properties, but the soils developed on it differ markedly from one another in many of their characteristics, in accordance with differences in the moisture conditions. In poorly drained basins throughout the loessial uplands, where water accumulates after rains, the soils show certain well-marked characteristics, particularly an advanced stage of leaching and concentration of clay in the subsoils. In well-drained but not severely eroded areas, the soils show less leaching and concentration of clay; and in steeply sloping areas, where surface run-off is rapid, they show neither characteristic. The loess covers all the uplands except a few areas in the western part of the county, which have either been covered or are greatly modified by wind-blown sand. The parent materials, from which the soils of the bottom lands are developing, consist of both loess and sand. They came partly from the local loessial uplands and partly from sandy areas to the west and were deposited as sediments in the valleys. None of them has lain in its present position long enough to have accumulated large amounts

of organic matter or to have been greatly altered by soil-forming processes. The character of the soils on the bottom lands, therefore, conforms rather closely to the character of the parent materials.

The mean annual precipitation in this county—23.07 inches—has not been sufficient for the growth of pure stands of tall grasses, and there is a mixture of both tall- and short-grass species. Organic matter, derived from decayed grass roots, has not been quite so abundant as in the tall-grass section to the east, and the soils have slightly lighter colored surface soils than those farther east. The moisture entering the ground has not been sufficient to leach deeply the readily soluble salts and lime carbonate, except in the more sandy soils and in those occupying poorly drained depressions, and nearly all of the soils have more lime at less depth than occurs in sections having greater precipitation. Throughout most of the smooth uplands in this county, the soils have a well-developed zone of carbonate enrichment in their subsoils.

In this report the soils have been arranged in 10 soil series, namely, Anselmo, Holdrege, Keith, Hall, Bridgeport, Colby, Valentine, Butler, Laurel, and Sarpy. The Holdrege, Keith, and Hall soils have formed under conditions especially favorable for deep soil development and the accumulation of organic matter. They occupy nearly level to undulating loessial areas, have developed under good surface drainage and underdrainage, and have lain in their present positions undisturbed by erosion for a long time.

Following is a description of a profile of Holdrege silt loam which occupies nearly all of the smooth well-drained loessial uplands. This profile, which is regarded as typical of normally developed soils in this section, was observed on a smooth upland divide in sec. 1, T. 6 N., R. 26 W.

1. 0 to 1½ inches, dark grayish-brown loose single-grain silt loam which is mulchlike when dry.
2. 1½ to 14 inches, dark grayish-brown silt loam. The upper 2-inch layer is faintly laminated, and the rest has a crumblike structure.
3. 14 to 22 inches, grayish-brown moderately heavy silty clay loam with a fine cloddy structure. This is the layer of maximum compaction, but its increased heaviness is noticeable only through close comparison with that of other layers in the profile.
4. 22 to 40 inches, light-gray or pale grayish-yellow floury massive silt loam with a high content of lime. The carbonate occurs in disseminated form and as powderlike coatings on the surfaces of clods. This is the zone of maximum lime enrichment.
5. 40 to 72 inches, pale yellowish-gray limy silt of the parent Peorian loess. The loess is limy but includes no zone in which the carbonates are segregated.

Adjoining the areas of Holdrege silt loam in the western part of the county are areas of Keith very fine sandy loam. The Keith soils, where typically developed, as in southwestern Nebraska and northwestern Kansas, are dominantly silt loams, but they have developed under rather arid conditions and differ from Holdrege silt loam in having slightly lighter colored surface soils and higher lying zones of carbonate accumulation. The Keith very fine sandy loam mapped in this county lies at the eastern edge of the Keith soil development and is more or less transitional in character between the typical Keith and the Holdrege soils.

Information on the chemical characteristics of the Holdrege and Keith soils is given by Brown, Rice, and Byers.[6]

The results of mechanical analyses of Keith very fine sandy loam are given in table 7.

TABLE 7.—*Mechanical analyses of Keith very fine sandy loam*

Sample No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
379109	Surface soil, 0 to 4 inches	0.0	0.0	0.2	1.9	52.1	28.7	17.0
379110	Subsurface soil, 4 to 16 inches	.0	.3	.2	1.7	40.4	36.3	21.1
379111	Subsoil, 16 to 28 inches	.0	.1	.1	1.6	50.0	26.5	21.7
379112	Subsoil, 28 to 38 inches	.0	.0	.0	2.5	57.8	15.3	24.3
379113	Subsoil, 38 to 58 inches	.0	.0	.0	2.3	58.1	23.1	16.5

Associated with Holdrege silt loam throughout the uplands in this county is Colby silt loam which also has developed from Peorian loess but under conditions unfavorable for the development of a regional profile. The relief in areas of Colby silt loam ranges from rolling to rough and broken, and surface run-off removes the products of soil development almost as fast as formed. Much of this soil is simply Peorian loess, the topmost few inches of which have been slightly darkened by organic matter.

Scattered throughout the more nearly level parts of the uplands and on terraces are a few small and shallow depressions, locally known as buffalo wallows, or lagoons, which are occupied by Butler silty clay loam. Water accumulates in these depressions after rains and often remains on the surface of the ground for several weeks at a time. Downward percolation of water is slow, and the results of poor drainage are pronounced. The surface soil is friable, or moderately so, and ranges from 8 to 12 inches in thickness. It has a mealy to crumblike structure. The basic color of this layer is almost black, but the material contains more or less light-gray or almost white leached floury silt, especially in the lower part, which in places is rather light colored. The upper part of the subsoil, which is about 2 feet thick, is a true claypan composed of very dark brown or almost black dense clay. The lower part of the subsoil is lighter in color and more friable than the upper part, although it contains some clay. Below a depth of 40 inches is yellowish-gray friable silt loam. A zone of lime development lies at a depth of about 5 feet in most places.

The soils of the terraces, or benches, in the larger stream valleys are classed with the Hall and Bridgeport series. The Hall soils have developed from silty sediments deposited by the streams when flowing at higher levels. They have lain in their present position long enough to have accumulated an abundance of dark organic material and to have developed definite layers, or horizons, resembling, in character, number, and position, those in the Holdrege soils of the well-drained uplands. The Bridgeport soils are of more recent origin, and their character depends largely on the character of the materials from which they have developed. Most of them have re-

[6] BROWN, IRVIN C., RICE, T. D., and BYERS, HORACE G. A STUDY OF CLAYPAN SOILS. U. S. Dept. Agr. Tech. Bull. 399, 43 pp. 1933.

ceived colluvial deposits that have been washed or have rolled down from the adjoining uplands.

A small area in the western part of the county is occupied by the Anselmo and Valentine soils which are composed mainly or entirely of sand. Neither of these soils has made much progress in development, largely owing to the incoherent character of the parent material and its resistance to weathering. They have light-colored surface soils, are low in organic matter, and are thoroughly leached of lime.

The Laurel and Sarpy soils of the bottom lands have developed from recently deposited stream sediments and have accumulated a moderate supply of organic matter, but, aside from their slightly darkened surface soils, they have no zones, or layers, of true soil character. They are grayish brown throughout. The Laurel soils have developed from the more silty sediments, and the Sarpy from sand.

SUMMARY

Frontier County is in the south-central part of Nebraska. It is rectangular in shape and comprises 975 square miles, or 624,000 acres.

Practically the entire county is in the loess section of the State. About 40 percent of the area consists of nearly level tableland, modified by the valleys of Medicine, Red Willow, Plum, East Muddy, and West Muddy Creeks and by numerous steep-sided drainageways. About 46 percent of the uplands is more or less eroded and ranges from rolling to rough and broken. The terraces and flood plains occupy broken and continuous strips of nearly level land along all the larger streams.

The average elevation of the county is about 2,600 feet above sea level, and the range in elevation is about 700 feet. The land slopes gradually downward toward the southeast. It is all well drained, except in small basinlike depressions scattered throughout the more nearly level uplands and in several small areas at the upper ends of artificial lakes in the bottom lands.

The county was organized in 1872. The first permanent settlement was made along Medicine Creek in the early seventies. The population in 1930, according to the Federal census, was 8,114, all classed as rural.

Transportation facilities are fair. All parts of the county are supplied with rural mail delivery, telephones are in common use, and the public-school system is well developed.

The climate is characterized by a rather low annual precipitation and a comparatively wide range in temperature. The mean annual temperature is 50.7° F., and the mean annual precipitation is 23.07 inches. About two-thirds of the moisture falls during the principal part of the growing season—May to September, inclusive. Short periods of drought often occur during the summer.

More than 40 percent of the total land area is under cultivation, and most of the rest is used for the grazing of cattle. The chief cultivated crop is corn which occupies more than 50 percent of the farmed land. Wheat, sorghum for grain and forage, oats, barley, and alfalfa rank next in acreage, in the order named. Other crops include sweetclover, rye, potatoes, and vegetables. A large proportion of the crops is fed to livestock, chiefly cattle and hogs, which are

the main sources of income. Wheat is the chief cash crop. Systematic rotation of crops is not practiced. No commercial fertilizer is used, but barnyard manure is applied on small areas of the bottom lands and on Colby silt loam of the uplands. On the basis of soil characteristics and other features that affect agriculture, the soils are placed in the following broad groups: (1) Well-drained soils of the uplands and terraces, (2) excessively drained soils of the uplands, (3) poorly drained soils of the uplands and terraces, and (4) variably drained soils of the bottom lands.

The cultivated soils, as a whole, are highly productive, provided enough moisture is available. They all contain an abundance of lime at a slight depth and have accumulated enough organic matter to supply an adequate amount of nitrogen. With only minor exceptions, they are friable and are penetrated easily by air, moisture, and plant roots.

Holdrege silt loam is a very extensive soil and the one on which the agriculture largely depends. It has developed from light-gray floury and limy silt, known geologically as Peorian loess, and it covers the greater part of the more nearly level and well-drained uplands. This soil is adapted to all crops common to the section, and nearly all of it is under cultivation.

Hall silt loam is similar to Holdrege silt loam in most soil characteristics and is used for the same crops. It occurs on well-drained terraces. It is somewhat more productive than Holdrege silt loam, however, owing to its lower position and consequently more favorable moisture supply.

Keith very fine sandy loam also is very similar to Holdrege silt loam, but it has a slightly lighter colored and more sandy surface soil and a higher lying zone of lime enrichment.

The Bridgeport soils occur on terraces similar to those occupied by Hall silt loam. They contain less organic matter in their surface soils and have slightly looser subsoils than do the Holdrege and Hall soils. The Bridgeport soils are about equal in productivity to Holdrege silt loam but are slightly less productive than Hall silt loam.

A group of light-colored soils of the uplands and terraces includes the Colby, Anselmo, and Valentine soils. None of these soils is as well suited for the growing of grain and tame hay as are the dark-colored soils. They are used chiefly as native pasture and hay land. The Colby soils, which are, by far, the most extensive soils of this group, occupy the more rolling parts of the loessial uplands where cultivation is difficult or impossible. Owing to rapid surface run-off, less water is available for the growth of plants, and erosion is greater than on the more nearly level land. The Colby soils are prevailingly low in organic matter and light in color.

The Anselmo and Valentine soils occur in the extreme western part of the county. The Anselmo soils are composed of mixtures of sand and silt, the former predominating. The Valentine soil consists almost entirely of sand and is not stable under cultivation. It occupies hummocky and rolling uplands and is best suited for pasture and hay land. All the light-colored soils are lower in organic matter and, as a rule, are less productive than the dark-colored soils.

Butler silty clay loam occurs in small widely scattered poorly drained depressions on the uplands and terraces. Only about 35 percent of the land is under cultivation.

The variably drained soils of the bottom lands are developing in narrow strips along most of the larger watercourses. They include the Laurel and Sarpy soils, most areas of which are well drained considering their low position. Their organic content is not high, but their abundant moisture supply enables them to give higher acre yields of corn and alfalfa than are obtained on the uplands and terraces, except in years when the bottoms are subject to overflow. The Laurel soils occur on the more silty bottom-land sediments and are finer textured than the Sarpy soils which are composed largely of fine sand.

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BUREAU OF CHEMISTRY AND SOILS

HENRY G. KNIGHT, *Chief.*

SOIL SURVEY DIVISION

CHARLES E. KELLOGG, *Chief.*

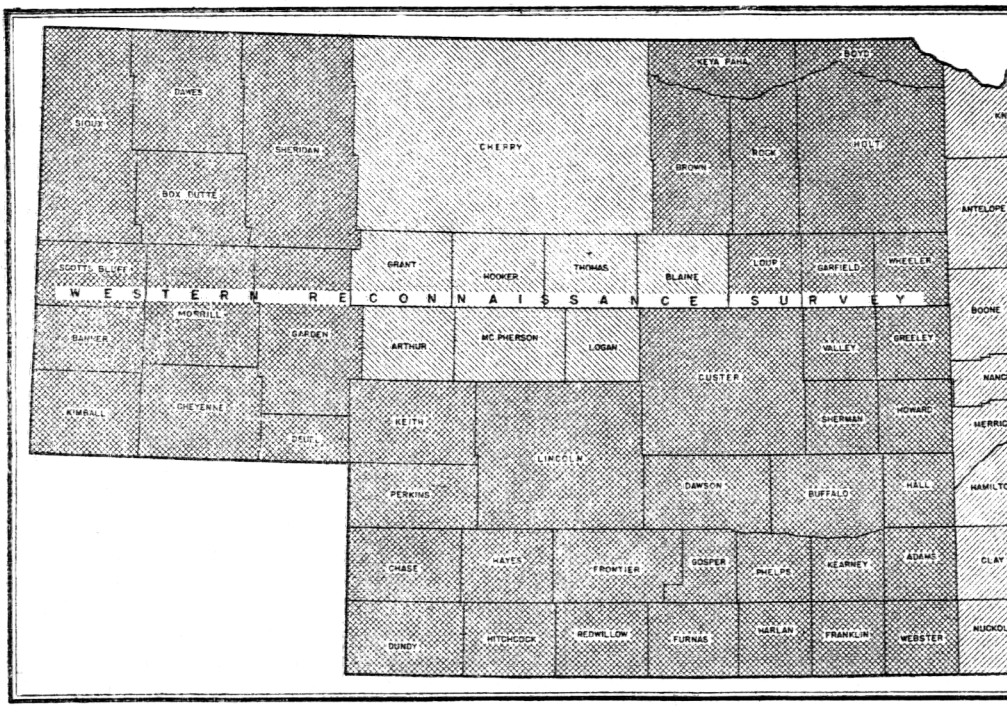
T. D. RICE, *Inspector, District 3.*

J. W. McKERICHER, *in Charge Map Drafting.*

UNIVERSITY OF NEBRASKA

STATE SOIL SURVEY DEPARTMENT OF THE CONSERVATION AND SURVEY DIVISION

G. E. CONDRA, *Dean and Director*



Areas surveyed in Nebraska shown by shading. Detailed surveys shown by northeast-southwest hatchi
west-southeast hatching; crosshatching indicates areas covered in b

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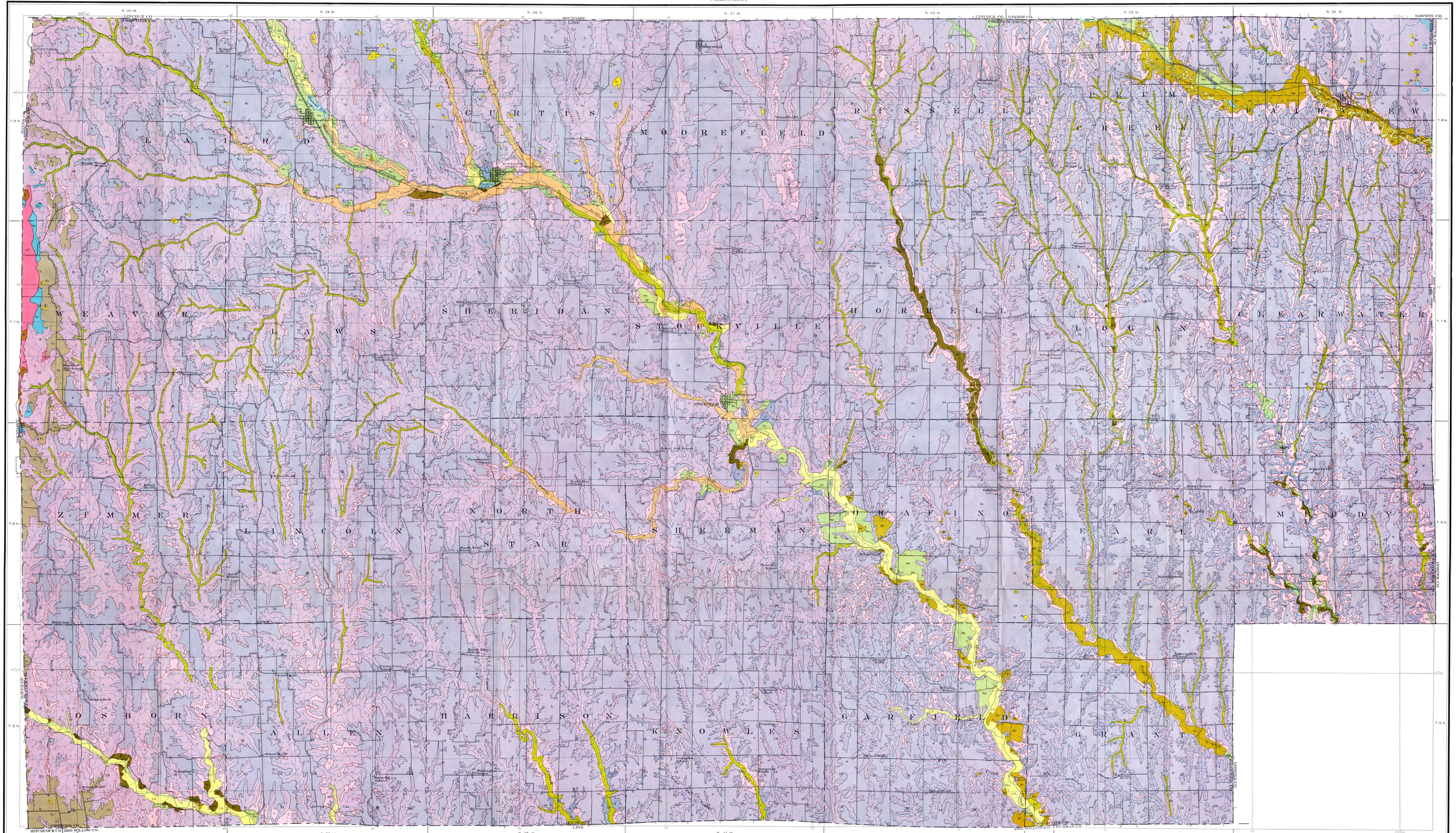
U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
HENRY G. KNIGHT, CHIEF
SOIL SURVEY DIVISION, CHARLES E. KELLOGG, CHIEF

SOIL MAP
FRONTIER COUNTY
NEBRASKA

UNIVERSITY OF NEBRASKA
STATE SOIL SURVEY DEPARTMENT OF THE
CONSERVATION AND SURVEY DIVISION
G. E. CONDRA, DIRECTOR



LEGEND

- Anselmo loamy fine sand — Al
- Hall silt loam — Hm
- Anselmo very fine sandy loam — Av
- Holdrege silt loam — H
- Bridgeport very fine sandy loam — Bv
- Holdrege Slope phase — H
- Bridgeport silt loam — Br
- Keith very fine sandy loam — Kv
- Butler silty clay loam — Bc
- Laurel very fine sandy loam — Lv
- Colby silt loam — C
- Laurel silt loam — Lo
- Colby Broken phase — C
- Sarpy very fine sandy loam — Sv
- Valentine fine sandy loam — Vf

CONVENTIONAL SIGNS

CULTURE
(Printed in black)

- City or Village, Roads, Buildings, Wharves, Levees, Breakwaters, Lighthouse, Fort
- Secondary roads and Trails
- Railroads, Steam and Electric
- Bridges, Ferry
- R.R. crossings, Tunnel
- Ford, Dam, Sawmill, Windmill
- Boundary lines
- School, Church, Creamery, Cemeteries
- Boundary lines
- Triangulation station, Boundary monument, Oil or Gas wells
- U.S. township and Section lines, Recovered corners
- Forest fire station, Lookout tower, Oil or Gas tanks
- Transmission line, Oil or Gas pipe line
- Mine or Quarry, Rock outcrop, Made land
- Soil boundaries, Sloughs, Gravelly and Cherty areas

RELIEF
(Printed in brown or black)

- Contours, Depression contours
- Prominent Hills, Mountain Peaks
- Sand, Wash, and Sand dunes
- Bluff, Escarpment, Mine dumps

DRAINAGE
(Printed in blue)

- Streams, Springs, Wells, Flowing wells
- Lakes, Ponds, Intermittent lakes
- Unsurveyed and Intermittent streams
- Water gaps, Rivers, Canals, Ditches, Flumes
- Swamp, Salt marshes
- Submerged marsh, Tidal flats

The above signs are as required and as shown on maps. Omissions from this list are unimportant on maps of certain areas.

Thomas D. Rice, Inspector, District 3.
Soils surveyed by S. R. Bacon, U. S. Department of Agriculture, in charge, and E. H. Tyner, W. L. Bruce, David Franzen, and D. B. Dobson, Nebraska Soil Survey.

Scale 1 inch-1 mile
1 0 1 2 3 Miles

Field Operations
Bureau of Chemistry and Soils
1935